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Response Of Soybean Growth In Sandy Coastal Soil To Seaweed Compost And Biochar Application

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Abstract. The coastal area is sub-optimal land which is poor in nutrients. Therefore it is necessary to add organic matter to increase nutrients content. The research that has been conducted aims to determine the effect of seaweed compost and biochar application on soybean growth on sandy coastal soils. The research was arranged in a Completely Randomized Design consisting of two factors. The first factor was the dose of seaweed compost, namely 0, 20, 40, 60. The second factor was giving biochar, namely without biochar and giving biochar. The research data were analyzed using Analysis of Variance, if there was a significant difference, it was tested with the Duncans Multiple Range test at the 5% level. The results showed that the interaction between seaweed compost and biochar significantly increased the growth rate of plant height. Biochar significantly increased plant dry weight and pod number. Seaweed compost only significantly increased root dry weight. The number of nodules, root length, and harvest index were not affected by seaweed compost and biochar.

1. Introduction

Indonesian region consists of 70 % of water, with a coastline of 95.181 km and a sea waters area of 5.8 million km [1]. Sandy coastal along the coastline contains the opportunity to be agriculturally developed but requires technological input to fix the soil properties. The main problem face by sandy coastal soil is low fertility rate, low water-binding ability, salinity, and erosion [2][3]. Some crops have been cultivated in sandy coastal soil or saline soil with technological input. Researches have been conducted regarding soybean cultivation in saline soil and sandy coastal line. Rhizobium japonicum inoculation on soybean in sandy coastal soil can increase the growth [4], soybean variety in saline soil know to have a different growth response [5].

One of the weaknesses of sandy coastal soil is the low ability to bind water thus making the low humidity. Apart from that the low fertility of the soil also becomes one of the obstacles of plant growth. One of the alternatives to overcome these obstacles is by using organic matter. The use of organic matter

can improve the physical, chemical, and biological properties of the soil [6][7]. The kind that is usually used in Indonesia is manure and compost. Compost used usually comes from plant litter or household waste. The farmer still seldom uses seaweed as the main ingredient of compost. Indonesia as a maritime country contains an abundance of seaweed resources but seldom used as organic matter for agriculture. The use of seaweed compost on soybean cultivation in sandy coastal soil is expected can overcome the low nutrient in the area. Seaweed is known to contain auxin, gibberellin, cytokinin that can boost plant growth [8], besides seaweed also contains trace mineral of Fe, B, Ca, Cu, Cl, K, Mg, Mn, P, and bio-methane [9].

Another organic matter used to fix soil productivity, carbon resources, and water percolation filtration is biochar. Biochar has a good potential as a carbon resource because it has a slow decomposition property and can last long in the earth [10]. Biochar is also an organic amendment that can improve soil productivity, nitrogen efficiency, and water. The use of biochar in the soil as ecosystem feedback of soil organic matter (SOM) and the nutrient cycle will affect the activities of microorganisms [7].

2. Material and Method

The research is conducted in Ngestiharjo, Kasihan, Bantul, Yogyakarta, Indonesia. The planting media used in sandy coastal soil that came from Samas beach in Kulonprogo, Yogyakarta. Seaweed used came from the sea area in Gunung Kidul, Yogyakarta. Seaweed is composted in advance before applied to the planting media. The composting process is conducted for a month with the addition of effective microorganisms. Biochar used came from wood charcoal through the pyrolysis process.

The research is conducted using completely randomized design (CRD), consisting of two factors with three repetitions. The factor I, seaweed compost does, consist of 4 levels: 0, 20, 40, 60 tons/ha-1. Factor II, biochar, consists of two levels: without biochar and giving biochar. The observation variable is conducted towards the growth rate of plant height, root length, dry weight of root, nodules, dry weight of the plant, pods number, and harvest index. The growth rate of plant growth is calculated using the formula below:

$$b = \frac{n\sum XiYi - (\sum Xi)(\sum Yi)}{n\sum Xi^2 - (\sum Xi)^2}$$

b = the growth rate of plant height.
X = plant age.
Y = plant height.

Data analysis using Analysis of Variance (ANOVA), if there was a significant difference, it was tested with the Duncan's Multiple Range Test at the 5% level.

3. Result and Discussion

Soybean growth response is observed at the vegetative and generative phase. This analysis result pictured on how soybeans respond to seaweed compost and biochar.

3.1. Vegetative Growth Response

The vegetative growth response of soybean in sandy coastal soil towards the administration of seaweed compost and biochar is observed in the growth rate of plant height, root nodules, dry weight of root, and dry weight of the plant. Analysis of Variance result showed that there was an interaction between biochar with seaweed compost affected the growth of plant height.

Table 1. Seaweed Compost and Biochar effect on the growth of plant height in sandy coastal soil

Biochar	Seaweed compost (ton/ha)			
	0	20	40	60
Without biochar	2,65 d	3,78 bc	3,44 cd	4,02 abc
Biochar	4,05 abc	3,49 cd	4,47 ab	4,80 a

The combination of seaweed compost and biochar complement each other in increasing the growth rate of plant height. The use of biochar could increase the benefits of seaweed. Result analysis showed that the highest growth of plant height found on soybean that application seaweed compost of 60 ton/ha and biochar. This showed that the application of seaweed compost of 60 ton/ha and biochar gives a good growth media for soybean vegetative growth. This is caused by seaweed contains growth hormones auxin [8]. Auxin will stimulate cell growth and division so it affected the growth of plant height.

A different response was found in the observation of root nodules. Result analysis of variance showed that the application of seaweed compost and biochar did not affect the number of root nodules and dry weight of root.

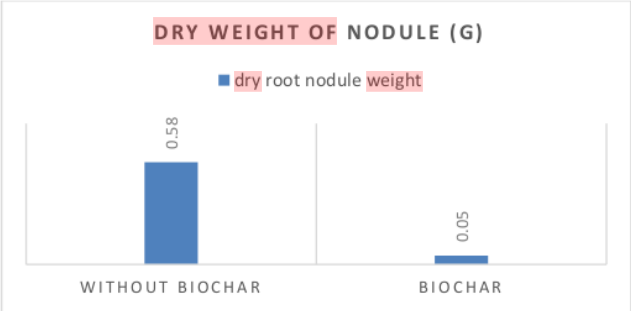

Figure 1. Biochar effects on the dry weight of nodule (g)

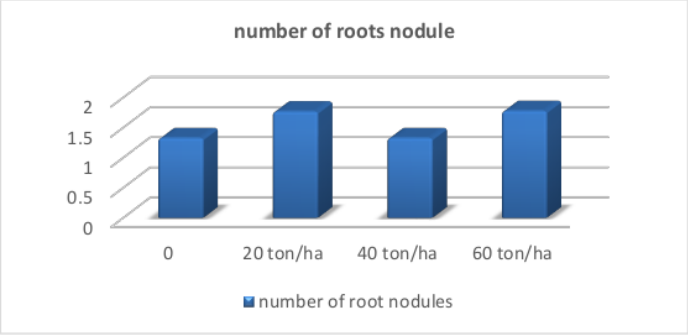

Figure 2. The effect of seaweed compost on nodule number.

The formation of root nodules happened when there are symbioses between Rhizobium bacteria with soybean plants [11]. The formation of root nodules is not affected by the nutrient content of growth hormone and mineral nutrients contained in seaweed compost and biochar. The nutrient found in biochar and seaweed compost did not affect the Rhizobium bacteria. The combination of application seaweed compost and biochar did not affect the dry weight of root that grew on sandy coastal soil. Biochar also did not affect the dry weight of root, but seaweed compost affected the dry weight of root.

The highest dry weight root is found in the plant that is applicated with seaweed compost of 40 ton/ha. A different result is found in the observation of dry weight of the plant. The dry weight of the plant is observed at the maximum vegetative growth phase. The dry weight of root showed the accumulation of photosynthesis results. The result analysis of variance showed biochar affect the dry weight of the plant, but seaweed compost did not. The application of biochar in planting media could increase the dry weight of the plant. This is caused by biochar can improve the physical, chemical, and biological properties of soil [10], Thus giving a good planting media for the plant to be better at photosynthesis, shown by the dry weight of the plant.

Table 2. the effect of seaweed compost and biochar towards root dry weight and plant dry weight.

Seaweed compost (ton/ha)	The Dry weight of root (g)	The Dry weight of plant (g)
0	1,05 b	6,76 a
20	1,25 b	8,08 a
40	1,87 a	8,91 a
60	1,05 b	9,58 a
Biochar application		
Without biochar	1,28 p	7,17 b
Biochar	1,33 p	9,5a 0 a

3.2. Generative growth response

The observation of generative growth response is conducted in the number of pods and harvest index. The result can be seen below in Table 3.

Table 3. the effect of seaweed compost and biochar towards pod number and harvest index

Seaweed compost (ton/ha)	Pod number	Harvest index
0	26,11 a	0,67 a
20	33,94 a	0,71 a
40	29,89 a	0,63 a
60	39,78 a	0,76 a
Biochar application		
Without biochar	26,05 q	0,65 p
Biochar	38,81 p	0,73 p

The application of biochar in sandy coastal soil planting media could increase the pod number but did not increase the harvest index. Biochar's ability in improving the soil properties could stimulate plant growth and photosynthesis showed by the accumulation of dry plant weight. This growth rate affected the plant production, showed by the pod number.

4. Conclusion

The respond of soybean growth in the sandy coastal soil toward the application of seaweed compost and biochar is shown in the vegetative and generative growth phase. The interaction between seaweed compost and biochar can increase the growth rate of plant height significantly. The growths of root nodules were not affected by the administration of seaweed compost and biochar. Seaweed compost could increase the dry weight of the root but did not increase the dry weight of the plant. The application of biochar could increase the dry weight of the plant.

Biochar application can increase the number of pods but did not increase the harvest index. Seaweed compost did not affect the plant production components.

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